Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Vol. XX. *January, 1911.* *No. 2*

BIOLOGICAL BULLETIN

CERTAIN HABITS, PARTICULARLY LIGHT REACTIONS, OF A LITTORAL ARANEAD.

THOS. H. MONTGOMERY, JR.

This tiny beach-comber has been identified by Mr. Nathan Banks as *Grammonota inornata* (Emert.), a species of theridiid, for which I am much indebted to him. It lives at Woods Hole, Mass., and in its vicinity, upon the sandy beaches along Vineyard Sound and Buzzards Bay. Here it is found, however, in only small scattered colonies for it occurs only on those sand beaches where the eel grass, thrown up by the sea, lies in more or less permanent lines upon the beach. Thus it does not exist upon gravelly or rocky beaches, nor yet upon sandy beaches devoid of the eel grass. The area of its distribution is limited to this cast-up eel grass, from a line slightly above high tide level landward as far as the patches of eel grass extend, a distance rarely exceeding ten or twelve feet and determined more or less by the degree of slope of the beach. In this peculiar home it obtains perpetual moisture and darkness, and does not migrate further up the beach nor into the salt marshes. In the same places occur a variety of animal forms in great individual abundance. Of this fauna the gammarids constitute the only truly marine element, the others being mainly terrestrial forms: certain other spiders, of which a drassid and the young of *Trochosa cinerea* are most abundant, staphylinid and chrysomelid beetles, an acarine, a pseudoscorpion and a chilopod. These are all normal constituents of this fauna, not waifs drifted in by the sea.[1]

My interest was drawn to them by the observation that when

[1] The elements of the "upper beach fauna" have been interestingly characterized by Davenport, "The Animal Ecology of the Cold Spring Sand Spit," Dec. Publ. Univ. Chicago, 1903. But he does not mention the particular species we are now considering.

they are disturbed by the removal of the eel grass, they all run directly landward provided only the sun is shining from an angle. Fifty or a hundred or more of these spiders may be set into commotion by the lifting up of a bunch of the eel grass, and under the conditions stated the large majority, sometimes all, of them invariably run in a straight course right up the beach and do not stop until they reach shelter beneath another mound of the eel grass. This habit is the more striking because none of the other species that live with them exhibit any such regular landward migration.

Direction and velocity of the wind have nothing to do with determining this course of running, for the landward migration occurs whether the wind blows upon the spiders from in front, or behind or from the side, or when there is no wind. Further, the spiders are not guided by any moisture sense, for (1) they do not regularly run landward when the sun is obscured, and (2) if the observer pours out sea water at a higher level and lets if flow down towards the spiders, they nevertheless continue their landward course. Again, this is not a geotropism, a tendency of the spiders to run up hill, nor an orientation to the rolling of sand grains. For the observer can dig a deep trench to landward of the spiders, and they will go down its declivity and up its opposite side without changing their course; or one can implant a board vertically in the sand in front of them, when they will climb up one surface of it and down the other without changing their general direction of movement.

Therefore the landward course of these spiders is not caused by any influence of wind or moisture or slope of the beach, but is probably a light reaction as the following observations would show.

When the sun is shining and when its rays come from an angle, at any time but noon, the spiders regularly run up the beach; this I have tested many times and on different beaches facing different points of the compass. That is, the spiders run up the beach whether the sun shines in front of, behind or to one side of them. But at noon, when the sun is nearly vertical, they run in all directions; and that they do also when the observer on a sunny day shades them with an umbrella.

Then a number of experiments were made to test the reactions of the spiders to the rays of an ordinary student oil lamp placed one foot or a foot and a half away from them, all these experiments being made at night. Numbers were caught and placed in small vials, which can be done without injury to them for they are hard-bodied. Then a piece of smooth white paper was laid horizontally upon the table, and kept free from sand or other particles; on this paper four quadrants were marked, the one nearest the lamp marked *A*, the one most distant from it *D* and the other two quadrants *C* and *B*. A vial was then uncorked and the spiders allowed to drop in succession gently upon the center of the paper, each falling slowly on its own drag line. With a pencil the course of each spider was then marked upon the paper, which made a permanent record of all movements of all individuals. On different nights a total of 107 spiders were thus tested, with the following results: 3 ran into quadrant *A*, directly towards the light; 45 ran into quadrant *D*, directly away from the light; 28 turned into quadrant *B* and 31 into quadrant *C*, these accordingly at right angles to the direction of the light. This proves negative phototropism to the rays of an oil lamp, for only 2.8 per cent. of the individuals ran towards the light. In these experiments it was purely a matter of chance how the spider was oriented when it first touched the paper. Of those that happened to touch it facing the light almost all moved through an arc of a circle so as to get into another direction and then continued their courses in almost straight lines; there was a marked turning away from the source of the light.

Another experiment was made with diffuse daylight. Eleven spiders were dropped in similar manner upon a piece of white paper placed on a table in the northwest corner of a room, sunlight entering the east window but not reaching the table. Ten of the spiders turned directly away from the sunlight, and one at right angles to it. This was then negative phototropism.

In a third experiment spiders were dropped upon a piece of white paper on which the sun shone directly, the sun being then near the meridian (10.45 A.M.). In this case ten moved towards the sunlight, one at right angles to it, and eight away from it.

This result seems at first sight to be contradictory to the preceding experiments. But I believe it is explainable by the nearly vertical position of the sun's rays; for on the beach, at noon when the sun is nearly vertical, the spiders do not run in any regular direction.

It thus seems that these spiders are decidedly negatively phototropic to lamplight and to diffuse daylight, when these impinge upon them from an angle; but that when sunlight falls upon them nearly vertically they do not orient themselves to it. How is it then on the beach that the spiders run so regularly landward whenever the sun is shining from an angle, irrespective of the position of the sun, which may be in front or behind or to the right or the left of them? One would not suppose it to be a case of negative phototropism when they run straight towards the sun. Yet I believe it is this nevertheless, in that the spiders may orient themselves not to the sun directly but to the light from the water. For the area of light in the sky and clouds above the water is certainly greater, and the light more intense, than that to landward, owing to the great amount of reflection from the water. It is well known that a man becomes more sunburnt upon the water, a test that the sunlight is more effective there. It would seem that only in this way can we correlate the experiments made with the oil lamp and with diffuse sunlight, with the observations recorded upon the sea beach. That animals react to area as well as to intensity of light is now well known. Thus G. H. Parker[1] showed that *Vanessa*, when in the open, always comes to rest with its head away from the sun, and that it thereby "reacts positively to large patches of bright sunlight rather than to small ones, even though the latter, as in the case of the sun, may be much more intense." Cole[2] has confirmed Parker's results, and concluded from his own painstaking observations on several forms, that animals with direction eyes, as those without eyes, respond to light intensity only; and that animals with image-forming eyes when positively

[1] "The Phototropism of the Mourning Cloak Butterfly, *Vanessa antiopa* Linn.," Mark. Anniv. Vol., 1903.

[2] "An Experimental Study of the Image-forming Powers of Various Types of Eyes," *Proc. Amer. Acad. Arts and Sci.*, 42, 1907.

phototropic react to the size of the luminous field or to definite objects in the visual field.

Our *Grammonota* probably possesses an image-forming eye, but it is negatively phototropic. Whether it reacts to intensity of the light or to its area remains to be determined. I have made no attempt to decide whether it reacts rather to the light rays than the heat rays, and I was not interested to determine this, for in the state of nature heat and light, so far as they affect these animals, are probably always associated.

Under natural conditions the masses of eel grass that shelter these spiders would be disturbed only by unusually high tides, perhaps occasionally also by violent winds. If the sun were shining during such a disturbance the spiders, from their negative phototropism, would attempt to run landward, and thus some of them might escape the action of the waves; but it is questionable whether this light reaction would be of any great benefit to them at times when the waves play havoc on the beach.

From the scattered distribution of these spiders one would suppose they might be readily transported by water. I accordingly made a few experiments to ascertain how sea water affects them. A number were dropped upon clean sea water placed in a glass dish; they were able to stand upon the surface film, but not to run unless there were fine dust particles upon it. But so soon as the water was violently agitated they sank below the surface and were unable to rise again. Therefore they could not long remain upon the top of a wave, but would become quickly submerged unless they clung to some floating vegetation. This is because the body is only slightly pilose. They become quiet after a few minutes of submergence, as though partially suffocated, yet they can withstand submergence for some hours. Thus I kept seven beneath water for five and a half hours, then placed them upon blotting paper to dry, when four revived; and I kept another lot beneath water for sixteen hours, and one of these revived after drying.

A number were placed in isolated vials, each with a few drops of sea water to furnish the necessary moisture, in order to observe the cocooning, but I was not so fortunate as to see this process. The cocoon is lenticular, snow-white and relatively

very large—its diameter considerably greater than the length of the spider. Nine cocoons were made in these vials, by as many females, and all at some time between 10:30 P.M. and 7 A.M., the time of cocooning would then seem to be nearly morning. On previous occasions I have indicated how regular this time is in spiders, and how it varies with different species.

Males are abundant through the summer months, but the mating was seen only in part although many of both sexes were kept in observation cages. A male and female were seen to move directly towards each other, and on meeting each elevated its head region so that the line of the body made an angle of about 45° with the floor, when the male extended his cephalothorax somewhat beneath and to one side of that of the female. This attitude is similar to that of *Dictyna*.

UNIVERSITY OF PENNSYLVANIA.